



CROCUS Technology
Blossoming future

“MLU”

Magnetic Logic Unit Architecture

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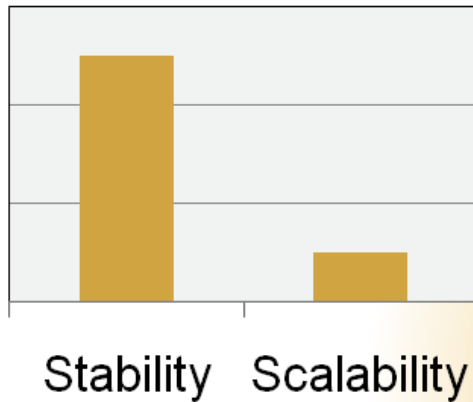


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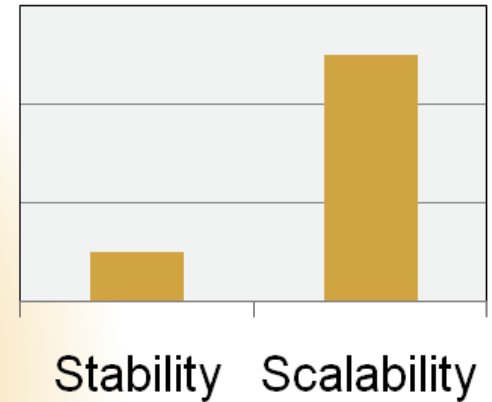
Thermally Assisted Switching (TAS)

The Heart of MLU

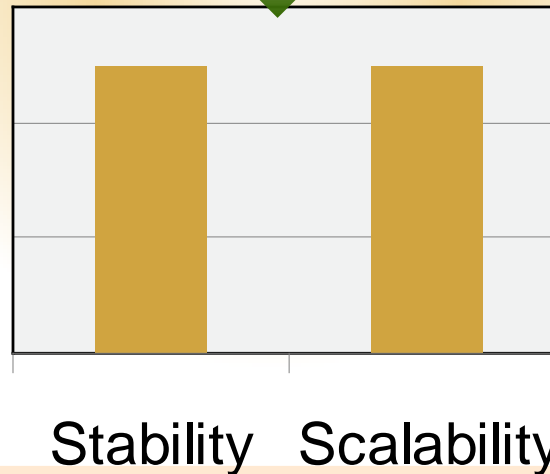
Before
TAS



Tradeoff:
Stability vs. Scalability



With
TAS



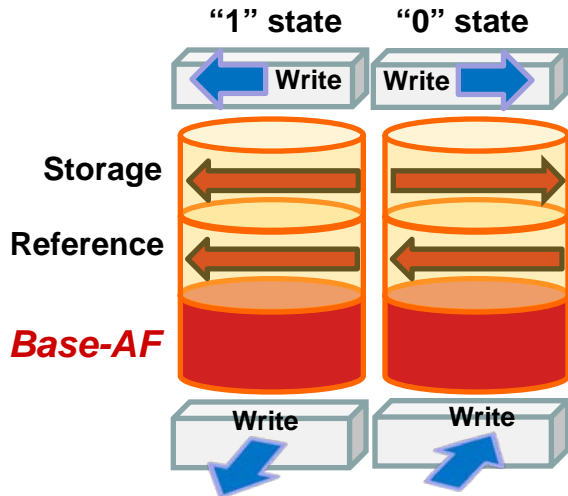
Crocus' TAS
approach solves
the primary
obstacle to high
density and
embedded MRAM



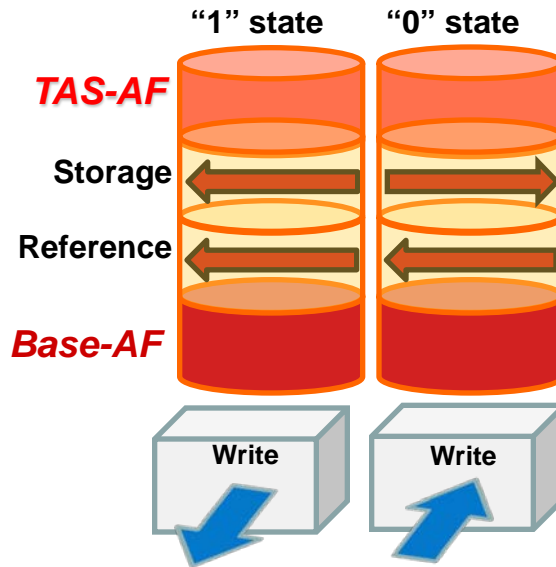
Progression to MLU

CROCUS

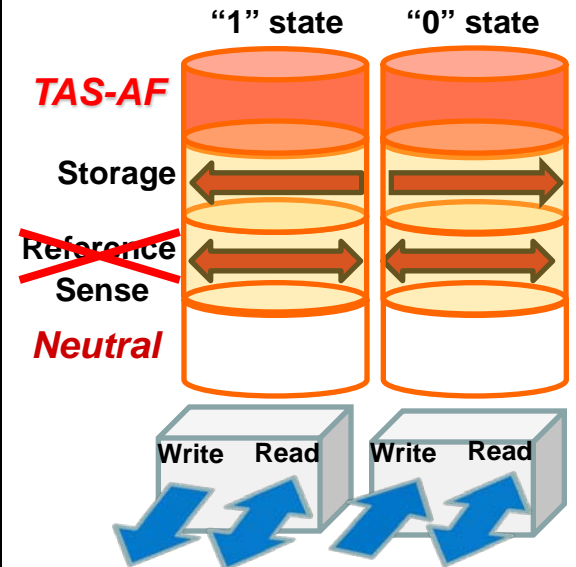
STD MRAM



TAS MRAM



MLU





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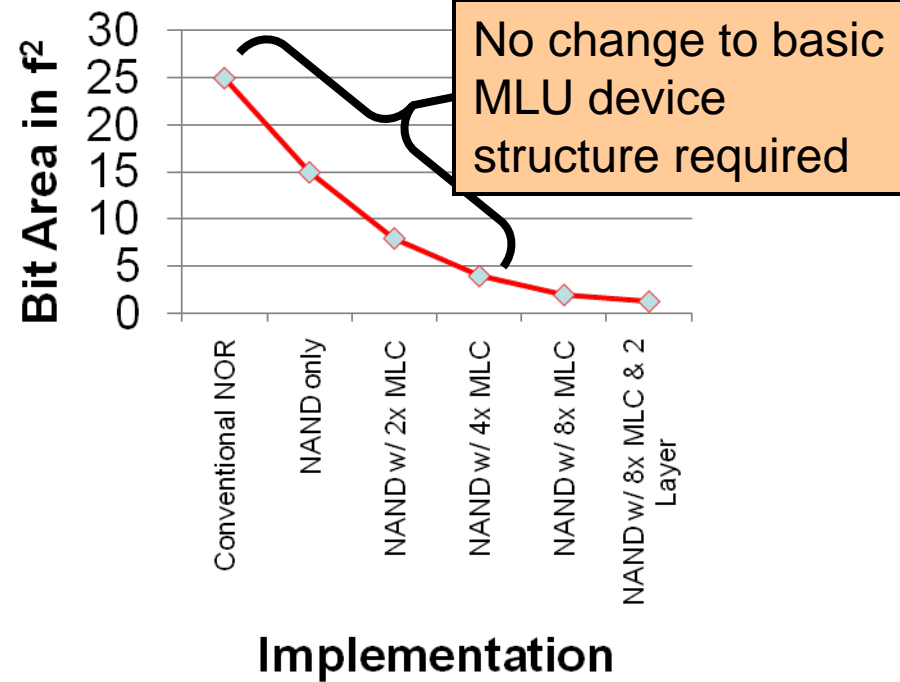
MLU Benefits



MLU Impact on Memory Density

TAS Architecture	Bit Density
Conventional NOR	$\sim 25 f^2$
NAND	1.5-3x density
MLC	2-8 bits/cell
Multi-layer	2+ layers

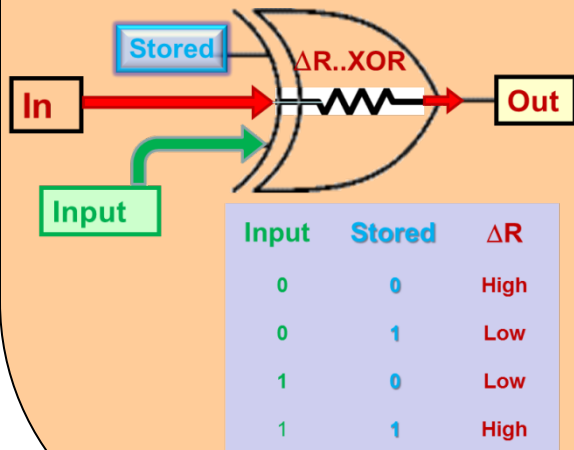
Cell Size per bit





MLU Impact on Logic Implementation

MLU implements
'native XOR'





MLU Impact on Device Operation and Manufacturing

High Temperature

>200° C NVM operation

Reference pinning layer removed

Simplified Manufacturing

No magnetic anneal
Reduced cost –
reference pin layer

Enhanced Yield

Self-differential reading
Relieve magnetic device
parameter constraints
>5x σ window imprvm't



- **MLU:**
 - Makes very high density MRAM possible
 - NAND and MLC are straightforward
 - Opens new logic applications for magnetic memory
 - CAM, Secure Memory, Pattern Matching, Look-up Table
 - Removes previous technology barriers
 - High temp NVM operation, greatly expanded yield window, lower cost wafer processing